

## REPORT DOCUMENTATION PAGE

AFRL-SR-BL-TR-01-

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Project, Washington, DC 20503.

0171

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE	3. REPORT TYPE AND DATES COVERED 01 April 1997 - 31 March 2000	
4. TITLE AND SUBTITLE DNA: Computation The Search for the "Killer" Application			5. FUNDING NUMBERS F49620-97-1-0190	
6. AUTHOR(S) Professor Lipton				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Princeton University Dept of Computer Science Princeton, NJ 08544			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFOSR 801 N. Randolph Street, Room 732 Arlington, VA 22203-1977			10. SPONSORING/MONITORING AGENCY REPORT NUMBER  F49620-97-1-0190	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION AVAILABILITY STATEMENT Approved for Public Release.			AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFOSR) NOTICE OF TRANSMITTAL DTIC. THIS TECHNICAL REPORT HAS BEEN REVIEWED AND IS APPROVED FOR PUBLIC RELEASE LAW AFR 190-12. DISTRIBUTION IS UNLIMITED.	
13. ABSTRACT (Maximum 200 words) We successfully expanded the field of "DNA Computers" to RNA to develop and execute a general approach for the solution of Satisfiability problems. A challenge to this field has been the need for a design that is scalable to more difficult computations.				
14. SUBJECT TERMS			15. NUMBER OF PAGES 1	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT	

**AFOSR Grant: F49620-97-1-0190****DNA Computation: The Search for the "Killer" application**

We successfully expanded the field of "DNA Computers" to RNA to develop and execute a general approach for the solution of Satisfiability problems. A challenge to this field has been the need for a design that is scalable to more difficult computations. In Faulhammer *et al.* (2000) we presented a scalable approach to computing by expanding the field of DNA computers to RNA, which can be cleaved in several parallel ways, and we used this approach to solve the most difficult problem to date using either molecular or quantum computing. As a demonstration of a general solution to a wide class of mathematical search problems, we solved a 9-bit instance of a satisfiability problem derived from chess, which the founder of this field regards as "the world champion so far" (Adleman in *Science* 2000, 287:1182). Using specific ribonuclease digestion to manipulate strands of a 10-bit binary RNA library, we developed a molecular algorithm and applied it to a  $3 \times 3$  chessboard as a 9-bit instance of this problem. Here, the nine spaces on the board correspond to nine 'bits' or placeholders in a combinatorial RNA library. We recovered a set of 'winning' molecules that describe solutions to this problem.

## Publications associated with award

- Faulhammer, D., Cukras, A. R., Lipton, R. J. and L. F. Landweber (2000) Molecular Computation: RNA Solutions to Chess Problems. *Proc. Natl. Acad. Sci. USA*. 97:1385-1389.
- Faulhammer, D., Lipton, R. J. and L. F. Landweber (in press) Fidelity of enzymatic ligation for DNA computing. *J. Comp. Biol.*
- Faulhammer, D., Lipton, R. J. and L. F. Landweber (2000) When the knight falls: On constructing an RNA computer. In *DNA Based Computers V*, E. Winfree, D. Gifford, eds. DIMACS Series in Discrete Mathematics and Theoretical Computer Science, American Mathematical Society, 54: 1-7.
- Cukras, A. R., Faulhammer, D., Lipton, R. J. and L. F. Landweber (1999) Chess Games: A Model for RNA Based Computation. In *DNA Based Computers IV*, L. Kari, ed. *Biosystems* 52:35-45.
- Faulhammer, D., Lipton, R. J. and L. F. Landweber (1999) Counting DNA: Estimating the complexity of a test tube of DNA. In *DNA Based Computers IV*, L. Kari, ed. *Biosystems* 52:193-6.
- Landweber, L. F., Lipton, R. J. and M. O. Rabin. (1999) DNA<sup>2</sup>DNA Computations: A Potential "Killer App"? In *DNA Based Computers III*, H. Rubin and D.H. Wood, eds. DIMACS Series in Discrete Mathematics and Theoretical Computer Science, American Mathematical Society, vol 48, 161-172.
- Landweber, L. F. and R. J. Lipton. (1997) DNA<sup>2</sup>DNA Computations: A potential 'killer app'? In *24th International Colloquium on Automata, Languages and Programming (ICALP)*, Lecture Notes in Computer Science, pages 672-683, Springer-Verlag.

20010326 130